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(54) Title: DEVICE FOR DETONATION-IMPULSE CLEANING OF INNER SURFACES OF A REACTOR FOR HIGH-PRESSURE COAL GASIFICATION

(57) Abstract:

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Device for detonation-impulse cleaning of inner surfaces of a reactor for high-pressure coal gasification

Area of technology of the invention:

The invention lies in the field of the processing industry and power engineering, especially the field of production of fuel gas based on high-pressure continuous gasification of coal, more exactly the field of application of shock waves for operational cleaning of the inner surfaces of gasification reactors.

According to the International Patent Classification the invention corresponds to symbol .....

Technical problem:

The technical problem which is solved by this invention is defined as follows: in the process of coal gasification, especially the process of continuous high-pressure gasification of powdered coal, how to prevent buildup of deposits on the inner surface of the gasification reactor. How to accomplish periodic removal of the deposit located on the surfaces of the reactor by shock waves of controlled intensity, which will be generated by detonation combustion of suitable reagents in a special detonation pipe, with an initial excess pressure in the reagents, and situated outside of the reactor. How to enable a reliable control and selection of the intensity of the generated shock waves while at the same time observing the condition that the device based on this cleaning method will be effective, safe in operation, and cheap. How to provide a safe application of the detonation waves for removal of deposits under the conditions of the explosive and inflammable atmosphere in the reactor.

The defined technical problem is solved by this invention of a device for detonation-impulse cleaning of inner surfaces of a reactor for high-pressure coal gasification.

Prior art:

Modern, highly efficient methods of coal gasification entail a continuous, high-temperature gasification of powdered coal in reactors with considerable excess pressure. Those methods are at present in a phase of laboratory or semi-industrial operation (e.g. VEW-coal conversion process, Dortmund-Gummersbach; Installation for coal gasification - Energoinvest, Sarajevo). The walls of the reactors intended for that gasification have to be reliably cooled and for this they are usually covered on the inside with registers of economizer or evaporator tubes with an organized circulation of coolant agent. Coal particles which in the gasification process come into contact with the walls of the reactor are cooled and, in a certain number of cases, are retained on the walls, thus forming a deposit on the tube registers that considerably increases the thermal resistance. Removal of these deposits during the gasification process is not reliably solved at present. Experiments with pneumatic vibrators (VEW-Dortmund) have not given satisfactory results, while the use of shock waves for this purpose, generated by presently known methods, such as by air guns or by known variants of the detonation-impulse method, is not possible on account of the high pressure in the gaseous environment of the reactor, and also because the gaseous environment in the reactor is in fact gas, which is likewise prone to detonation combustion. Specifically, the intensity of the shock waves that are generated by air guns is not sufficient for emission in the high-pressure gaseous environment of the reactor (pressure above ten bars), while the presently known variants of the detonation-impulse methods of cleaning (Kazan University - USSR; VUZES, Brno - Czechoslovakia, Mechanical Engineering College, Sarajevo - Yugoslavia) involve the generation of shock waves in impulse-detonation chambers with initial pressure of the reagents slightly above atmospheric pressure and at the same time with the open end of the chamber bound directly to the object being cleaned--without any closure elements. Since a high pressure prevails in the gaseous environment of the reactor, that method cannot be used for cleaning a reactor. Another problem is to provide such a detonation-impulse method of cleaning which guarantees that no such quantity of oxidizers will get into the explosive environment of the reactor as might result in an explosion in the reactor.

Description of the solution of the technical problem:

The invention entitled "Device for detonation-impulse cleaning of the inner surfaces of a reactor for high-pressure coal gasification" is shown in the drawings, namely:

Fig. 1 -- shows the basic solution of the invention, in which the initial pressure of the reagents in the detonation pipe is less than the pressure in the reactor and in which shock waves are generated on the basis of burning of fuel stored in an external source

Fig. 2 -- shows variant I of the invention, designed so that the initial pressure of the reagents in the detonation pipe is equal to the pressure in the reactor, and so that gas from the reactor is used as fuel for generating the shock waves.

In both of the solutions of this invention, shown in Fig. 1 and 2, the shortcomings mentioned in the prior art have been eliminated and a reliable removal of deposits from the coal gasification reactor is assured, in that, as claimed in Fig. 1, the outside of the pipe (26) of the reactor (25) is cleaned by shock waves which are generated in the detonation pipe (16) by forced burning of a mixture at a sufficient initial excess pressure, which is previously formed in the mixer (13), in such a way that a suitable flammable gas, suitably stored in the vessel (1), is let into a stable current of compressed air (line 9) by the opening of a magnetic valve (8), periodically, at appropriate pressure. During the time of filling with reagents, the detonation pipe (16) is separated from the gaseous environment of the reactor (25) by an impulse valve with pneumatic or hydraulic motor (22), which opens suddenly, shortly after the forced ignition of the mixture by the ignition source (17), admitting the already formed shock wave of particular intensity into the gaseous environment of the reactor, after which the valve (22) closes, also suddenly. After this, the magnetic valve (20) opens, thus allowing a continuous stream of air, which is taken into the detonation pipe (16) for a certain time through the mixture line (14), without mixing with the gas in the mixer (13) (the magnetic valve (8) is closed), while the products remaining after the detonation are removed from the detonation pipe (16) via the aerodynamic valve (19) with a vent (21). With this, the detonation pipe is in fact ready for another filling with mixture and for another detonation. By control fittings placed on the gas line (3) and the air line (9), and with the aid of flow meters (7) and (12), a nearly stoichiometric, but fuel-enriched mixture is formed in the ejector type mixer (13), which prevents the appearance of oxygen in the products after the detonation, while the inert exhaust which is partly emitted into the reactor from the shock wave after the opening of the impulse valve (22) cannot further enter into reaction with the gas in the reactor. Selecting an appropriate initial pressure of the reagents in the detonation pipe (16) -- which incidentally is still less than the pressure of the gaseous environment in the reactor (25) -- ensures the generation of shock waves whose intensity is such that the emitting of the waves inside the reactor is assured.

Variant I of the invention, shown in Fig. 2, affords generation of shock waves by detonation combustion of a mixture of compressed air (line 9) and gas from the gasification reactor (25), after forced ignition of the mixture by an ignition source (17) in the detonation pipe (16), at whose open end, with an enlargement (32) connected to the reactor (25), there are no closure elements at all, while the initial pressure of the reagents in the pipe (16) is equal to the pressure of the gaseous environment in the reactor. According to Fig. 2, the mixture of reagents is formed directly in the detonation pipe, in that a certain quantity of air, compressed by the compressor (2), is admitted into the cooled reactor gas which is already in the pipe (16), via the return valve (15) and the perforated pipe (28), by the opening of the magnetic valve (27). After being formed, the mixture, which is also fuel-enriched, but nearly stoichiometric, is forcibly ignited and burns before its moving boundary surface reaches the heated wire (31), whose purpose is to prevent any possible inflow of explosive mixture from the detonation pipe (16) into the reactor (26), where high temperatures prevail and where said mixture would spontaneously ignite. Because of the high initial pressure of the reagents, very powerful shock waves are generated in the detonation pipe (16), and the purpose of the enlargement (32) at the open end of the detonation pipe is to enable an expansion, as well as a sufficient weakening of the so generated shock waves before they are emitted into the gas space of the reactor. For a new detonation, the detonation pipe is filled with reactor gas, owing to the pressure difference, via the open end (32), and the portion of products from the previous detonation remaining behind at the closed end of the detonation pipe (16) is vented, by opening of the magnetic valve (30), via the vent (29), at whose end is likewise placed a heated wire (34) for burning that quantity of reactor gas that may have been mixed with the products and gotten in through the vent. After closing of the magnetic valve (30), the detonation pipe (16) is again filled with air and the process repeats itself. The cooling system for the detonation pipe (33) is connected to the cooling system for the reactor (26), and at the same time it chills the generator gas in the detonation pipe below the temperature of self-ignition. In both variants of the invention, the process is automatically controlled from a command cabinet (24) by means of cables for command voltages (a) through (k).

The device for detonation-impulse cleaning of inner surfaces of a reactor for high-pressure coal gasification--the basic solution of the invention (Fig. 1)--consists of several suitably interconnected units. The fuel gas line consists of a suitable number of cylinders with stored gas (1), as well as a gas transport pipe (3), whose design includes an intervention-computing check valve (4), a reduction valve for manual adjustment of the pressure in the second part of the gas tract (5), a safety valve with spring (6), a flow metering throttle (7), and a magnetic valve (8). The compressed air line consists of the compressor (2) and air transport pipe (9),

whose design includes a manual intervention valve (10), a manual pressure reduction valve (11) and a flow metering throttle (12). The mixture of air and gas of corresponding (explosive) composition is formed in an ejector type mixer (13) by adjusting appropriate predetermined flow rates of gas and air. These flow rates are read off on flow meters (7) and (12), and if necessary are corrected at the reduction valves (5) and (11). The mixture is formed such that gas is periodically admitted into a stable current of air by the opening of the magnetic valve (8). The mixture formed in this way is taken by the ready mixture line (14), across the return valve (15), to the detonation pipe (16), namely, its closed end, where is also situated an electrical source for forced ignition of the mixture (17). The quantity of mixture that is admitted into the detonation pipe prior to ignition depends on the time of holding the magnetic valve (8), in the gas line, in the open position, and in this way, and also by adjusting the reduction valves (5) and (11) used to regulate the pressure of the reagents in the pipe (16), in fact, to regulate the intensity of the shock waves generated. The detonation pipe (16) is a pipe of appropriate diameter with one closed end, and whose other end, across an impulse valve with pneumatic or hydraulic motor (without a firm connection to the structure of the reactor) is introduced into the interior of the gasification reactor (25). The system for cooling the open end of the detonation pipe (23) also cools the impulse valve (22), and is connected to the cooling system of the reactor (26). A turbulizer (e.g. a perforated diaphragm) (18) is placed inside the detonation pipe at a distance, calculated in relation to the closed end of this pipe, equal to five times the diameter of the flow cross section of the detonation pipe, and its task is to turbulize the flow of reagents and oncoming flame in the predetonation combustion and thereby facilitate a faster establishment of conditions for the detonation combustion of the remaining portion of reagents. Immediately after the ignition of the mixture by the source (17), the magnetic valve closes in the gas line (8), due to the pressure difference the return valve closes in the mixture line (15), and the impulse valve (22) opens and the shock wave is emitted into the reactor. After this, the impulse valve (22) closes, the pressure difference will open the return valve (15), through which, this time, only air will come into the detonation pipe, and it will flush the detonation pipe of remaining combustion products through the aerodynamic valve (19) and the vent (21), by the opening of the magnetic valve (20) for this purpose. For still some time after the closing of the magnetic valve (20), only air will be admitted into the detonation pipe in order to adjust the given excess pressure in the reagents prior to burning, and after this the detonation pipe will be filled with a certain quantity of explosive mixture at the closed end, by the opening of the magnetic valve (8), and the process will repeat itself. The magnetic valves (8) and (20), the impulse valve (22) and the source for forced ignition of mixture (17) are automatically controlled, by means of cables for command voltage (b), (e), (f) and (d) from the command unit (24), in the design of which they are

placed in interlock by means of cables (a) and (c) for automatic shutoff of the system in the event of occurrence of mutually inconsistent flow rates of gas and air.

The device for detonation-impulse cleaning of inner surfaces of a reactor for high-pressure coal gasification-- variant I of the invention (Fig. 2)--consists of the compressed air line (9), whose design includes the compressor (2), the intervention-computing check valve (10), the reduction valve for manual regulation of the pressure (11), the magnetic valve (27), the flow metering throttle (12), the return valve (15) and the perforated pipe (28), which is placed with its perforated part in the detonation pipe (16) with turbulizer (18) and source for forced ignition of the mixture (17) located at the closed end of the detonation pipe. The explosive mixture of reagents--reactor gas and air--is formed in such a way that a certain quantity of air is admitted into the reactor gas, cooled by the cooling system (33), which gas, through the open end without closure elements, fills the detonation pipe (16) to a pressure equal to the working pressure of the gaseous environment in the reactor, by the opening of the magnetic valve (27), such that this quantity of air, by means of the perforated pipe (28), is uniformly distributed in a certain volume of the detonation pipe, situated at its closed end. After reaching an explosive concentration of the mixture, which is checked by the intensity (flow meter 12) and dwell time of the air flow (the time during which the magnetic valve 27 is held in the open position), the magnetic valve (27) closes, and the mixture is lit by the ignition source (17). Since the shock wave developed in this way is rather weak in the appropriate enlargement (32), a shock wave of appropriate intensity is emitted into the gas space of the reactor (25), after which the detonation pipe is filled by a new quantity of reactor gas through its open end. After this, any combustion products which might be remaining at the closed end of the detonation pipe are released into the atmosphere, by the opening of the magnetic valve (30), through the vent (29), at the end of which is placed a heated wire (34) in order to burn off any escaping quantities of reactor gas. After the closing of the magnetic valve (30), as a result of a new quantity of air being admitted into the detonation pipe, an appropriate quantity of explosive mixture is again formed and burned, and the process continues. The purpose of the heated wire (31), placed in front of the open end of the detonation pipe, is to prevent any explosive mixture from getting inside the reactor, where said mixture would burn spontaneously, because of the high temperature. The process is automatically controlled by the command unit (24) and cables for command voltages (a), (d), (h), (i), (j) and (k).

Patent claims:

1. Device for detonation-impulse cleaning of inner surfaces of a reactor for high-pressure coal gasification, characterized in that the pipe for ready mixture of reagents (14) with a return valve (15) is led into the detonation pipe (16) upstream from a turbulizer (18), in that the detonation pipe (16) is separated from the reactor gas space (25) by an impulse valve with pneumatic or hydraulic motor (22), in that there is placed on the detonation pipe (16), upstream from the impulse valve (22), an aerodynamic valve (19) with vent (20) and magnetic valve (20), and in that at the open end of the detonation pipe (16) and impulse valve (22) there is placed a cooling system (23), which is connected to the cooling system for the walls of the reactor (26).
2. Device for detonation-impulse cleaning of inner surfaces of a reactor for high-pressure coal gasification, as claimed in claim 1, characterized in that the pipe for ready mixture of reagents (14) is connected to an ejector type mixer (13), to which are connected at the other side a gas line (3) with cylinders of compressed gas (1) and an air line (9) from the compressor (2), in that on the gas line (3) and air line (9) are placed manual check valves (4) and (10), and then manual reduction valves (5) and (11) and flow meters (7) and (12), in that the gas line (3) also contains a safety valve (6) and magnetic valve (8), in that the magnetic valves (8) and (20), the impulse valve (22) and the source of ignition (17) are connected by command voltage cables (b), (e), (f) and (d) to a command cabinet (24), and in that the command cabinet (24) is connected by signal cables (a) and (c) to the flow meters (7) and (12).
3. Device for detonation-impulse cleaning of inner surfaces of a reactor for high-pressure coal gasification, as claimed in variant I, characterized in that the air line (9), across a return valve (15) and a perforated pipe (28), is directly introduced into the detonation pipe (16) with turbulizer (18) and source of forced ignition (17), in that the detonation pipe (16) by its open end, across an enlargement (32) is directly introduced into the gas space of the reactor (25) without closure elements, in that the outer wall for the entire length of the detonation pipe (16) is covered by a cooling system (33), which is connected to the cooling system of the reactor (26), in that a heated wire (31) is placed at the open end of the detonation pipe (16), and in that at the closed end of the detonation pipe (16) is placed a vent (29) with magnetic valve (30) and heated wire (34).
4. Device for detonation-impulse cleaning of inner surfaces of a reactor for high-pressure coal gasification, as claimed in claim 3, characterized in that the design of the air line (9) includes, downstream from the high-pressure compressor (2), a magnetic valve (27), in that the magnetic valves (27) and (30), as well as the source of forced ignition (17), are

connected by command voltage cables (d), (h) and (i) to a command cabinet (24), and in that the command cabinet (24) is connected by multiple-core cables (j) and (k) to the heated wires (31) and (34), and by the signal cable (a) to the flow meter (12).

Summary of the essence of the invention:

The invention refers to a device for detonation-impulse cleaning of inner surfaces of a reactor for high-pressure coal gasification, for which, besides a basic solution, one variant solution of the device is also given.

The basic solution of the invention involves the removal of deposits from inner surfaces of a reactor (26) by shock waves which are generated in a detonation pipe (16), situated outside of the reactor, by a detonation combustion of a previously prepared mixture, prepared in a particular way, of reagents--air and a suitable gaseous fuel. Via the mixer (13), the reagents are introduced into the detonation pipe (16) and compressed to a suitable initial pressure--less than the pressure in the gaseous environment of the reactor. The detonation pipe is automatically separated from the gaseous environment of the reactor by a controlled impulse valve with pneumatic or hydraulic motor (22), which opens suddenly after the ignition of the mixture in the detonation pipe, admitting the shock wave into the reactor, and then it closes suddenly.

The variant solution of the device is based on the generating of shock waves by forced ignition of a mixture of generator gas and compressed air at an initial pressure equal to the pressure in the gaseous environment of the reactor (26). At the open end of the detonation pipe (16) there are no closure elements, but instead a widening (32) ensures a sufficient weakening of the waves before they are emitted into the reactor.

Proposal for best method of economical use of the invention:

The device for detonation-impulse cleaning of inner surfaces of a reactor for high-pressure coal gasification gives best results in relation to loose deposits, and therefore it needs to be used on a preventive basis, during operation of the reactor, and consequently quite often (e.g. 3 to 6 times in the course of 24 hours). Long interruption in cleaning may lead to hardening of the deposits on the walls of the reactor, making it more difficult to remove them. One cleaning with this device entails generating a series of 10-15 shock waves. If required, one can also place several detonation pipes on a reactor with centralized preparation of the explosive mixture.

The detonation pipes need to have a diameter of 150-200 mm and a length of 10-15 m, and one end needs to be closed. By its other, open end, the detonation pipe is introduced into the gas space of the reactor in a suitable place--usually in the region of lower temperatures. It is necessary to allow for dilatation of the open end of the detonation pipe, in relation to the wall of the reactor. For pressure of the gaseous environment of the reactor from 25 bar onward and introduction of external fuel for generating the wave, it is recommended that the initial pressure of the reagents in the detonation pipe be 4-5 bar. To generate one shock wave, one requires 0.4-0.7 Nm^3 of mixed reagents, in a given ratio

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Device for detonation-impulse cleaning of inner surfaces of a reactor for high-pressure coal gasification (main solution of the invention)

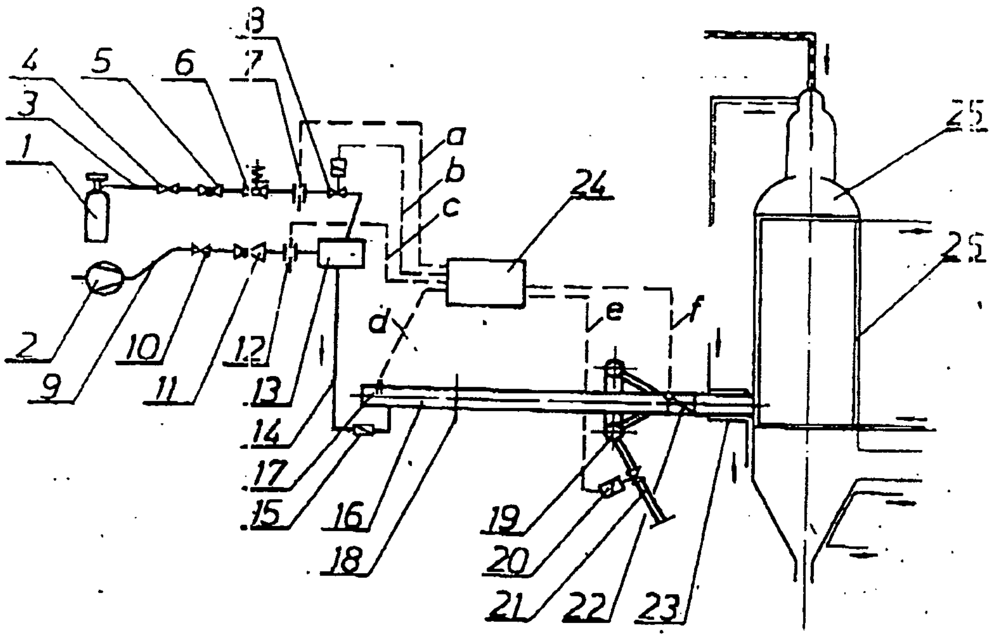

Fig. 1

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Device for detonation-impulse cleaning of inner surfaces of a reactor for high-pressure coal gasification (variant I of the solution)

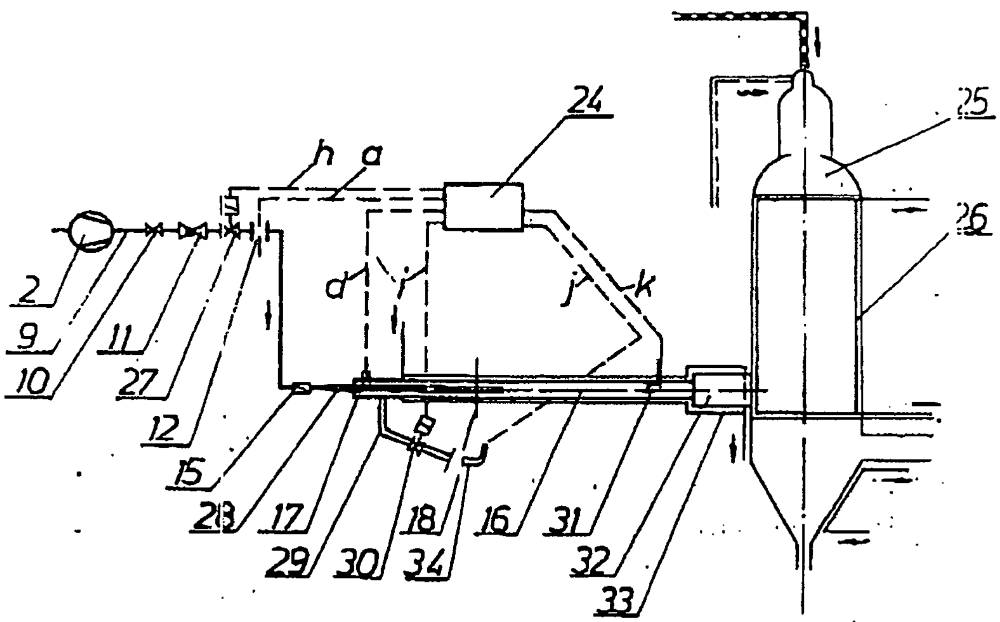

Fig. 2

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(54) Naziv: UREDJAJ ZA DETONACIONO-IMPULSNO ČIŠĆENJE UNUTRAŠNJIH POVRŠINA REAKTORA ZA VISOKOPRITISNU GASIFIKACIJU UGLJA

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Uredjaj za detonaciono-impulsno čišćenje unutrašnjih površina reaktora za visokopritisnu gasifikaciju uglja

Oblast tehnike u koju spada pronalazak:

Pronalazak spada u oblast procesne industrije i energetike, posebno u oblast proizvodnje gorivog gasa na bazi visokopritisne kontinuirane gasifikacije uglja, odnosno u oblast primjene udarnih talasa na pogonsko čišćenje unutrašnjih površina reaktora za gasifikaciju.

Prema Medjunarodnoj klasifikaciji patenata pronalasku odgovara simbol........

Tehnički problem:

Tehnički problem koji se rješava ovim pronalaskom je definisan na sljedeći način: Kako u procesu gasifikacije uglja, posebno u procesu visokopritisne kontinuirane gasifikacije sprašenog uglja, spriječiti rast depozita na unutrašnjoj površini reaktora za gasifikaciju. Kako postići da se depozit uspostavljen na površinama reaktora povremeno odnosi udarnim talasima kontrolisane jačine koji će se generisati detonacionim sagorijevanjem pogodnih reagenasa u posebnoj, detonacionoj, cijevi sa početnim nadpritiskom u reagensima, a smještenoj izvan reaktora. Kako omogućiti pouzdanu kontrolu i izbor jačine generisanih udarnih talasa uz istovremeno poštivanje uvjeta da uredjaj zasnovan na ovom postupku čišćenja bude efikasan, siguran u pogonu i jeftin. Kako obezbijediti sigurnu primjenu detonacionih talasa za otklanjanje naslaga u uslovima eksplozivne i zapaljive atmosfere u reaktoru.

Definisani tehnički problem je riješen ovim pronalaskom uredjaja za detonaciono-impulsno čišćenje unutrašnjih površina reaktora za visokopritisnu gasifikaciju uglja.

Stanje tehnike:

Savremeni, visokoefektivni, postupci gasifikacije uglja podrazumijevaju visokotempératúrnu kontinuiranu gasifikaciju sprašenog uglja u reaktorima sa značajnim nadpritiskom. Ovakvi postupci su danas u fazi laboratorijskog ili poluindustrijskog uhodavanja (npr. VEW-coal conversion process, Dortmund-Gummersbach; Postrojenje za gasifikaciju uglja - Energoinvest, Sarajevo). Zidovi reaktorâ namijenjenih ovakvoj gasifikaciji moraju biti pouzdano hladjeni i zato se na unutrašnjoj strani obično pokrivaju registrima ekonomajzerskih ili isparivačkih cijevi sa organizovanom cirkulacijom rashladnog medija. Čestice uglja koje u procesu gasifikacije dodju u kontakt sa zidovima reaktora se hlade i, u odredjenom broju slučajeva, zadržavaju na zidovima gradeći tako na cijevnim registrima depozit koji značajno povećava toplotni otpor. Odnošenje ovih naslaga, za vrijeme trajanja gasifikacije, u dosadašnjoj praksi nije pouzdano riješeno. Pokušaji sa pneumatskim vibratorima VEW-Dortmund) nisu dali zadovoljavajuće rezultate, a primjena u tu svrhu udarnih talasa generisanih do sada poznatim postupcima, na primjer vazdušnim topovima ili poznatim varijantama detonaciono-impulsnog postupka, nije moguća zbog visokog pritiska u gasnoj sredini reaktora, ali i zbog toga što je gasna sredina reaktora, ustvari, plin takodje sklon detonacionom sagorijevanju. Naime, jačina udarnih talasa koji se generišu vazdušnim topovima nije dovoljna za emitovanje u visokopritisnu gasnu sredinu reaktora (pritisak više desetina bara), a do sada poznate varijante detonaciono-impulsnih postupaka čišćenja (Kazanski univerzitet - SSSR; VUZES, Brno - ČSSR, Mašinski fakultet, Sarajevo - Jugoslavija) podrazumijevaju generisanje udarnih talasa u impulsno-detonacionim komorama sa početnim pritiskom reagenasa malo iznad atmosferskog i istovremeno sa neposredno vezanim otvorenim krajem komore za objekat čišćenja - bez zapornih organa. Kako u gasnoj sredini reaktora vlada visok pritisak ovakav se postupak ne može primjeniti na čišćenje reaktora. Problem je, takodje, obezbjediti takav detonaciono-impulsni postupak čišćenja koji garantuje da u eksplozivnu sredinu reaktora neće prodrijeti takva količina oksidanta koja bi mogla dovesti do eksplozije u reaktoru.

Opis rješenja tehničkog problema:

Pronalazak naslovljen kao: "Uredjaj za detonaciono-impulsno čišćenje unutrašnjih površina, reaktora za visokopritisnu gasifikaciju uglja", je pokazan na crtežima i to:

slika 1 - prikazuje osnovno rješenje pronalaska u kojemu je početni pritisak reagenasa u detonacionoj cijevi manji od pritiska u reaktoru i u kojemu se udarni talasi generišu na bazi spaljivanja goriva uskladištenog u vanjskom izvoru

slika 2 - prikazuje varijantu I pronalaska koncipiranu tako da je početni pritisak reagenasa u detonacionoj cijevi ravan pritisku u reaktoru i da se kao gorivo za generisanje udarnih talasa, koristi plin iz reaktora.

U oba rješenja ovog pronalaska, koja su data na slikama 1 i 2, eliminisani su nedostaci navedeni u stanju tehnike i obezbjedjeno je pouzdano odnošenje naslaga iz reaktora za gasifikaciju uglja, jer se, prema slici 1, vanjska strana cijevi (26) reaktora (25) čisti udarnim talasima koji se generišu u detonacionoj cijevi (16) prinudnim paljenjem smješe na dovoljnom početnom nadpritisku, koja se prethodno formira u mješaču (13) na taj način da se u stalan tok stlačenog vazduha (linija 9), otvaranjem magnetnog ventila (8), povremeno, na odgovarajućem pritisku, upušta pogodan gorivi gas odgovarajuće uskladišten u posudi (1). Za vrijeme punjanja reagensima detonaciona cijev (16) je od gasne sredine reaktora (25) odvojena impulsnom klapnom sa pneumatskim ili hidrauličnim motorom (22), koja se, kratko nakon prinudnog palenja smješe izvorom palenja (17), naglo otvara propuštajući već oformljen udarni talas odredjene jačine u gasnu sredinu reaktora, nakon čega se klapna (22), takodje naglo, zatvara. Nakon ovoga se otvara magnetni ventil (20), čime se omogućava kontinuiranoj struji vazduha, koji se odredjeno vrijeme, kroz liniju smješe (14), uvodi u detonacionu cijev (16), bez mješanja sa plinom u mješaču (13) (magnetni ventil (8) zatvoren), da iz detonacione cijevi (16), kroz aerodinamički ventil (19) sa oduškom (21), odstrani produkte zaostale nakon detonacije. Ovim se detonaciona cijev, ustvari, priprema za novo punjenje smješom i novu detonaciju. Upravljačkom armaturom postavljenom na liniju plina (3) i liniju vazduha (9), a uz pomoć protokomjera (7) i (12) se, u mješaču ejektorskog tipa (13) formira skoro stehiometrijska, ali gorivom bogata, smješa, čime je u produktima nakon detonacije spriječena pojava kiseonika, pa inertni ispuh koji se, po otvaranju impulsne klapne (22), iza udarnog ta-

lasa, djelimično emituje u reaktor ne može stupiti u dopunsku reakciju sa gasom u reaktoru. Izborom odgovarajućeg početnog pritiska reagenasa u detonacionoj cijevi (16) - koji je, medjutim, još uvijek manji od pritiska gasne sredine u reaktoru (25), je obezbjedjeno generisanje udarnih talasa čija je jačina takva da je osigurano emitovanje talasa u unutrašnjost reaktora.

Varijanta I pronalaska, pokazana na slici 2, obezbjedjuje generisanje udarnih talasa detonacionim sagorijevanjem smješe komprimiranog vazduha (linija 9) i gasa iz reaktora za gasifikaciju (25), nakon prinudnog paljenja smješe izvorom paljenja (17) u detonacionoj cijevi (16), u čijem otvorenom kraju sa proširenjem (32), vezanom za reaktor (25), ne postoje nikakvi zaporni organi, pa je početni pritisak reagenasa u cijevi (16) ravan pritisku gasne sredine u reaktoru. Prema slici 2 se smješa reagenasa formira direktno u detonacionoj cijevi tako da se u ohladjen reaktorski gas, koji se već nalazi u cijevi (16), kroz povratnu klapnu (15) i perforiranu cijev (28), otvaranjem magnetnog ventila (27), upušta odredjena količina vazduha kojeg tlači kompresor (2). Nakon formiranja se smješa, koja je, takodje gorivom bogata, ali bliska stehiometrijskoj, prinudno pali i sagorijeva prije nego što joj pokretna granična ravan naidje na užarenu žicu (31) koja ima zadatak da spriječi, makar i eventualan, dotok eksplozivne smješe iz detonacione cijevi (16) u reaktor (26) gdje vladaju visoke temperature i gdje bi se ta smješa spontano upalila. Zbog visokog početnog pritiska reagenasa se, u detonacionoj cijevi (16), generišu veoma jaki udarni talasi, i zadatak proširenja (32) na otvorenom kraju detonacione cijevi je da omogući ekspanziju, pa tako i dovoljno slabljenje, ovako generisanih udarnih talasa prije njihovog emitovanja u gasni prostor reaktora. Za novu detonaciju detonaciona cijev se, usljed razlike pritisaka, puni reaktorskim plinom kroz otvoreni kraj (32), a dio produkata od prethodne detonacije, koji je zaostao uz zatvoreni kraj detonacione cijevi (16), se ispušta, otvaranjem magnetnog ventila (30)., kroz odušak (29) na čijem je kraju, radi spaljivanja one količine reaktorskog gasa koja eventualno izmješana sa produktima prodire kroz odušak, takodje postavljena užarena žica (34). Po zatvaranju magnetnog ventila (30) detonaciona cijev (16) se ponovo dopunjava vazduhom i proces se ponavlja. Sistem za hladjenje detonacione cijevi (33) je vezan za sistem hladjenja reaktora (26), a istovremeno podhladjuje generatorski plin u detonacionoj cijevi ispod temperature, samozapaljenja. U obe varijante pronalaska procesom se, posredstvom kablova za komandni napon (a) do (k), automatski upravlja sa komandnog ormara (24).

Uredjaj za detonaciono-impulsno čišćenje unutrašnjih površina reaktora za visokopritisnu gasifikaciju uglja - osnovno rješenje pronalaska (slika 1) se, sastoji iz nekoliko, na odgovarajući način, medjusobno vezanih cjelina. Linija gorivog plina se sastoji od odgovarajućeg broja boca sa uskladištenim plinom (1), te od cijevi za transport plina (3) u čijem sklopu su postavljeni interventni - računi zaporni ventil (4), redukcioni ventil za ručno podešavanje pritiska u drugom dijelu plinske trase (5), sigurnosni ventil sa oprugom (6), protokomjer - prigušnica (7) i magnetni ventil (8). Linija stlačenog vazduha se sastoji od kompresora (2) i transportne cijevi za vazduh (9) u čijem sklopu se nalazi ručni interventni ventil (10), ručni ventil za redukciju pritiska (11) i protokomjer-prigušnica (12). Smješa vazduha i plina odgovarajućeg (eksplozivnog) sastava formira se u mješaču ejektorskog tipa (13) postizanjem odgovarajućih, unaprijed zadatih, protoka plina i vazduha. Ovi se protoci očitavaju na protokomjerima (7) i (12), a po potrebi koriguju na redukcionim ventilima (5) i (11). Smješa se formira tako da se u stalnu struju vazduha, otvaranjem magnetnog ventila (8), povremeno upušta plin. Ovako oformljena smješa se linijom gotove smješe (14), preko povratne klapne (15) uvodi u detonacionu cijev (16) i to uz njen zatvoreni kraj, gdje je smješten i električni izvor za prinudno paljenje smješe (17). Količina smješe koja se upušta u detonacionu cijev prije paljenje zavisi od vremena u kojemu se magnetni ventil (8), na liniji plina, drži u otvorenom položaju, te se na taj način, kao i podešavanjem redukcionih ventila (5) i (11), čime se reguliše pritisak regenasa u cijevi (16), ustvari, reguliše jačina generisanih udarnih talasa. Detonaciona cijev (16) je cijev odgovarajućeg prečnika sa jednim zatvorenim krajem, a čiji je drugi kraj, preko impulsne klapne sa pneumatskim ili hidrauličnim motorom (bez čvrste veze sa konstrukcijom reaktora) uveden u unutrašnjost reaktora za gasifikaciju (25). Sistem za hladjenje otvorenog kraja detonacione cijevi (23) ujedno hladi i impulsnu klapnu (22), a povezan je sa rashladnim sistemom reaktora (26). Turbulizator (npr. perforirana blenda) (18) je postavljen u unutrašnjost detonacione cijevi na udaljenosti, računato u odnosu na zatvoreni kraj te cijevi, ravnoj petorostrukom prečniku protočnog presjeka detonacione cijevi, a zadatak mu je da, u preddetonacionom sagorijevanju, turbulizira tok reagenasa i nailazeći plamen i na taj način doprinese što bržem uspostavljanju uslova za detonaciono sagorijevanje preostalog dijela reagenasa. Neposredno po paljenju smješe izvorom (17), zatvara se magnetni ventil na liniji plina (8), usljed razlike pritisaka zatvara se povratna klapna na liniji smješe (15), a otvara se impulsna klapna (22) i udarni talas se emituje u unutrašnjost reaktora. Nakon ovoga se zatvara impulsna klapna (22), razlika pritisaka će otvoriti povratnu klap-

nu (15) kroz koju će u detonacionu cijev ulaziti, ovaj put, samo vazduh koji će preko aerodinamičkog ventila (19) i oduška (21) sa, u tu svrhu, otvorenim magnetnim ventilom (20) isprati detonacionu cijev od zaostalih produkata sagorjevanja. Još neko vrijeme, po zatvaranju magnetnog ventila (20) u detonacionu cijev će se, radi postizanja zadatog nadpritiska u reagensima prije palenja, upuštati samo vazduh, a zatim će se, otvaranjem magnetnog ventila (8), detonaciona cijev uz zatvoren kraj dopuniti odredjenom količinom eksplozivne smješe i proces će se ponoviti. Magnetnim ventilima (8) i (20), impulsnom klapnom (22) i izvorom za prinudno paljenje smješe (17) automatski se, posredstvom kablova za komandni napon (b), (e), (f) i (d), upravlja sa komandnog bloka (24) u sklopu kojeg su, posredstvom kablova (a) i (c), smještene u blokade za automatsko isključivanje sistema iz pogona u slučaju uspostavljanja medjusobno neprimjerenih protoka plina i vazduha.

Uredjaj za detonaciono-impulsno čišćenje unutrašnjih površina reaktora za visokokopritisnu gasifikaciju uglja - varijanta I pronalaska (slika 2), se sastoji iz linije stlačnog vazduha (9), u čijem se sklopu nalaze kompresor (2), interventni - ručni zaporni ventil (10), redukcioni ventil za ručnu regulaciju pritiska (11), magnetni ventil (27), protokomjer - prigušnica (12), povratna klapna (15) i perforirana cijev (28), koja je svojim perforiranim dijelom smještena u detonacionoj cijevi (16) sa turbulizatorom (18) i izvorom za prinudno paljenje smješe (17) smještenim uz zatvoreni kraj detonacione cijevi. Eksplozivna smješa reagenasa - reaktorskog gasa i vazduha, formira se tako da se u, sistemom za hladjenje (33), ohladjen reaktorski gas koji, kroz otvoren kraj bez zapornik organa, popunjava detonacionu cijev (16) na pritisku ravnom radnom pritisku gasne sredine u reaktoru, otvaranjem magnetnog ventila (27), upušta odredjena količina vazduha tako da se ta količina vazduha, posredstvom perforirane cijevi (28) ravnomjerno rasporedjuje u odredjenoj zapremini detonacione cijevi smještenoj uz njen zatvoren kraj. Po dostizanju eksplozivne koncentracije smješe, što se kontroliše intenzitetom (protokomjer 12) i vremenom trajanja protoka vazduha (vrijeme u kojem je magnetni ventil 27 držan u otvorenom položaju), zatvara se magnetni ventil (27), a smješa se pali izvorom paljenja (17). Jak udarni talas koji se ovako razvija dovoljno slabi u primjerenom proširenju (32), te se udarni talas primjerene jačine emituje u gasni prostor reaktora (25), nakon čega detonacionu cijev kroz njen otvoren kraj, popunjava nova količina reaktorskog gasa. Nakon ovoga se produkti sagorjevanja, eventualno zaostali uz zatvoren kraj detonacione cijevi, ispuštaju u atmosferu, otvaranjem magnetnog ventila (30), kroz odušak (29) na čijem je kraju, radi spaljiva-

nja eventualno propuštenih količina reaktorskog gasa, postavljena užarena žica (34). Po zatvaranju magnetnog ventila (30) u detonacionu cijev se, upuštanjem nove količine vazduha, ponovo formira odgovarajuća količina eksplozivne smješe koja se pali i proces se nastavlja. Zadatak užarene žice (31), smještene pred otvorenim krajem detonacione cijevi, je da spriječi makar i eventualan prodor eksplozivne smješe u unutrašnjost reaktora gdje bi se ta smješa, zbog visoke temperature spontano upalila. Procesom se, preko komandnog bloka (24) i kablova za komandni napon (a), (d), (h), (i), (j) i (k), upravlja automatski.

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Z. 9.

Patentni zahtjev:

1. Uredjaj za detonaciono-impulsno čišćenje unutrašnjih površina reaktora za visokopritisnu gasifikaciju uglja, naznačen time, što je cijev gotove smješe reagenasa (14) sa povratnom klapnom (15) uvedena u detonacionu cijev (16) prije turbulizatora (18), što je detonaciona cijev (16) od reaktorskog gasnog prostora (25) odvojena impulsnom klapnom sa pnaumatskim ili hidrauličnim motorom (22) što je na detonacionoj cijevi (16), prije impulsne klapne (22) postavljen aerodinamički ventil (19) sa oduškom (20) i magnetnim ventilom (20) i što je na otvoreni kraj detonacione cijevi (16) i impulsne klapne (22) postavljen sistem za hladjenje (23) koji je vazan za sistem hladjenja zidova reaktora (26).

2. Uredjaj za detonaciono-impulsno čišćenje unutrašnjih površina reaktora za visokopritisnu gasifikaciju uglja, prema zahtjevu 1, naznačen time, što je cijev gotove smješe reagenasa (14) vezana za mješač ejektorskog tipa (13), za koji su na drugoj strani vezani plinovod (3) sa bocama stlačenog plina (1) i zrakovod (9) sa kompresora (2), što su u liniji plina (3) i liniji zraka (9) postavljeni ručni zaporni ventili (4) i (10), zatim ručni redukcioni ventili(5) i (11) i protokomjeri (7) i (12), što se u liniji plina (3) još nalaze sigurnosni ventil (6) i magnetni ventil (8), što su magnetni ventili (8) i (20), te impulsna klapna (22) i izvor paljenja (17) kablovima komandnog napona (b), (e), (f) i (d) vezani za komandni ormar (24) i što je komandni ormar (24) signalnim kablovima (a) i (c) povezan sa protokomjerima (7) i (12).

3. Uredjaj za detonaciono-impulsno čišćenje unutrašnjih površina reaktora za visokopritisnu gasifikaciju uglja, prema varijanti I, naznačen time, što je zrakovod (9), preko povratne klapne (15) i perforirane cijevi (28) direktno uveden u detonacionu cijev (16) sa turbulizatorom (18) i izvorom prinudnog paljenja (17), što je detonaciona cijev (16) svojim otvorenim krajem, preko proširenja (32), direktno-bez zapornih organa, uvedena u gasni prostor reaktora (25). što je vanjski zid, po cijeloj dužini detonacione cijevi (16), pokriven rashladnim sistemom (33), koji je vezan za rashladni sistem reaktora (26), što je u otvoreni kraj detonacione cijevi (16) postavljena užarena žica (31) i što je uz zatvoreni kraj detonacione cijevi (16) postavljen odušak (29) sa magnetnim ventilom (30) i užarenom žicom (34).

4. Uredjaj za detonaciono - impulsno čišćenje unutrašnjih površina reaktora za visokopritisnu gasifikaciju uglja, prema zahtjevu 3, naznačen time,što je u sklopu zrakovoda (9), iza visokotlačnog kompresora (2) postavljen magnetni ventil (27), što su magnetni ventili (27) i (30), kao i izvor prinudnog paljenja (17), kablovima komandnog napona (d), (h) i (i) povezani sa komandnim ormarom (24) i što je komandni ormar (24) posredstvom višežičnih kablova (j) i (k) povezan sa užarenim žicama (31) i (34), a posredstvom signalnog kabla (a) sa protokomjerom (12).

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Kratak sadržaj suštine pronalaska:

Pronalazak se odnosi na uredjaj za detonaciono - impulsno čišćenje unutrašnjih površina reaktora za visokopritisnu gasifikaciju uglja pri čemu je, pored osnovnog, dato i jedno varijantno rješenje uredjaja.

Osnovno rješenje pronalaska podrazumijeva odnošenje depozita sa unutrašnjih površina reaktora (26) udarnim talasima koji se, u detonacionoj cijevi (16) smještenoj izvan reaktora, generišu detonacionim sagorijevanjem, na odredjen način prethodno pripremljene, smješe reagenasa - vazduha i odgovarajućeg plinovitog goriva. Reagensi se, preko mješača (13), uvode u detonacionu cijev (16) i tlače na odgovarajući početni pritisak - manji od pritiska u gasnoj sredini reaktora. Detonaciona cijev je od gasne sredine reaktora odvojena automatski upravljanom impulsnom klapnom sa pneumatskim ili hidrauličnim motorom (22) koja se, po paljenju smješe u detonacionoj cijevi naglo otvara propuštajući udarni talas u reaktor , a zatim se naglo zatvara.

Varijantno rješenje uredjaja je zasnovano na generisanju udarnih talasa prinudnim paljenjem smješe generatorskog plina i stlačenog vazduha na početnom pritisku ravnom pritisku u gasnoj sredini reaktora (26). U otvorenom kraju detonacione cijevi (16) nema zapornih organa, ali je proširenjem (32) obezbjedjeno dovoljno slabljenje talasa prije njihovog emitovanja u reaktor.

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SARAJEVO

Navod o najboljem načinu za privrednu upotrebu pronalaska:

Uredjaj za detonaciono-impulsno čišćenje unutrašnjih površina reaktora za visokopritisnu gasifikaciju uglja daje najbolje rezultate u odnošenju sipkih naslaga i zato ga, u pogonu reaktora, treba upotrebljavati preventivno, dakle dovoljno često (npr. 3 do 6 puta u toku 24 časa). Duži prekid u čišćenju može dovesti do očvršćavanja naslaga na zidovima reaktora, pa tako i njihovog težeg odnošenja. Jedno čišćenje ovim uredjajem podrazumijeva generisanje serije od $10 \div 15$ udarnih talasa. Na reaktor se, po potrebi, može postaviti i više detonacionih cijevi sa centralnom pripremom eksplozivne smješe.

Detonacione cijevi trebaju imati prečnik $150 \div 200$ mm i dužinu $10 \div 15$ m, a jedan kraj im treba zatvoriti. Drugim, otvorenim, krajem detonaciona cijev se, na odgovarajućem mjestu - obično u području nižih temperatura, uvodi u gasni prostor reaktora. Potrebno je omogućiti dilataciju otvorenog kraja detonacione cijevi u odnosu na zid reaktora. Pri pritisku gasne sredine reaktora od 25 bara i uvodjenju vanjskog goriva za generisanje talasa preporučuje se početni pritisak reagenasa u detonacionoj cijevi $4 \div 5$ bara. Za generisanje jednog udarnog talasa potrebno je $0{,}4 \div 0{,}7$ Nm^3, u odredjenom omjeru, izmješanih reagenasa.

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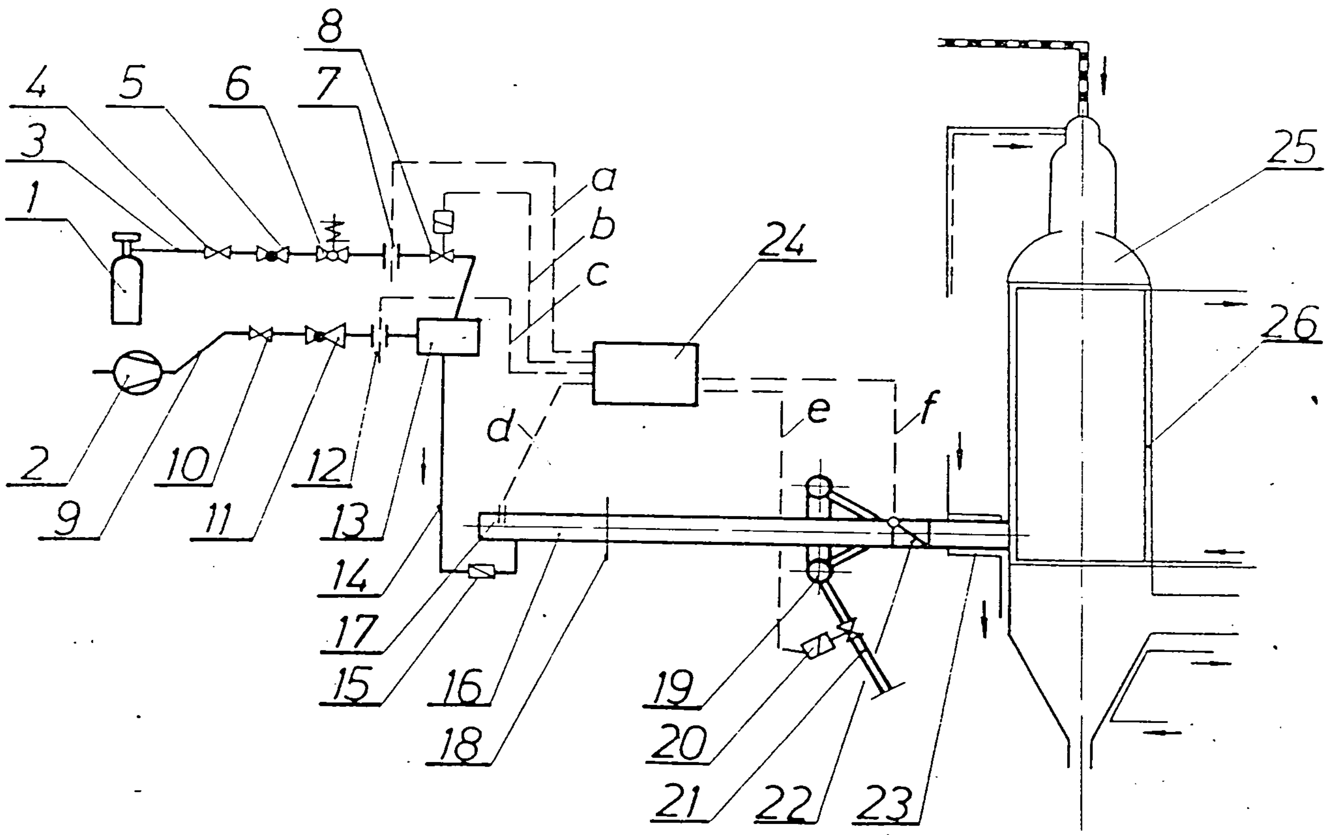
Uredaj za detonaciono-impulsno čišćenje unutrašnjih površina reaktora za visokopritisnu gasifikaciju uglja (osnovno rješenje pronalaska)



Slika 1

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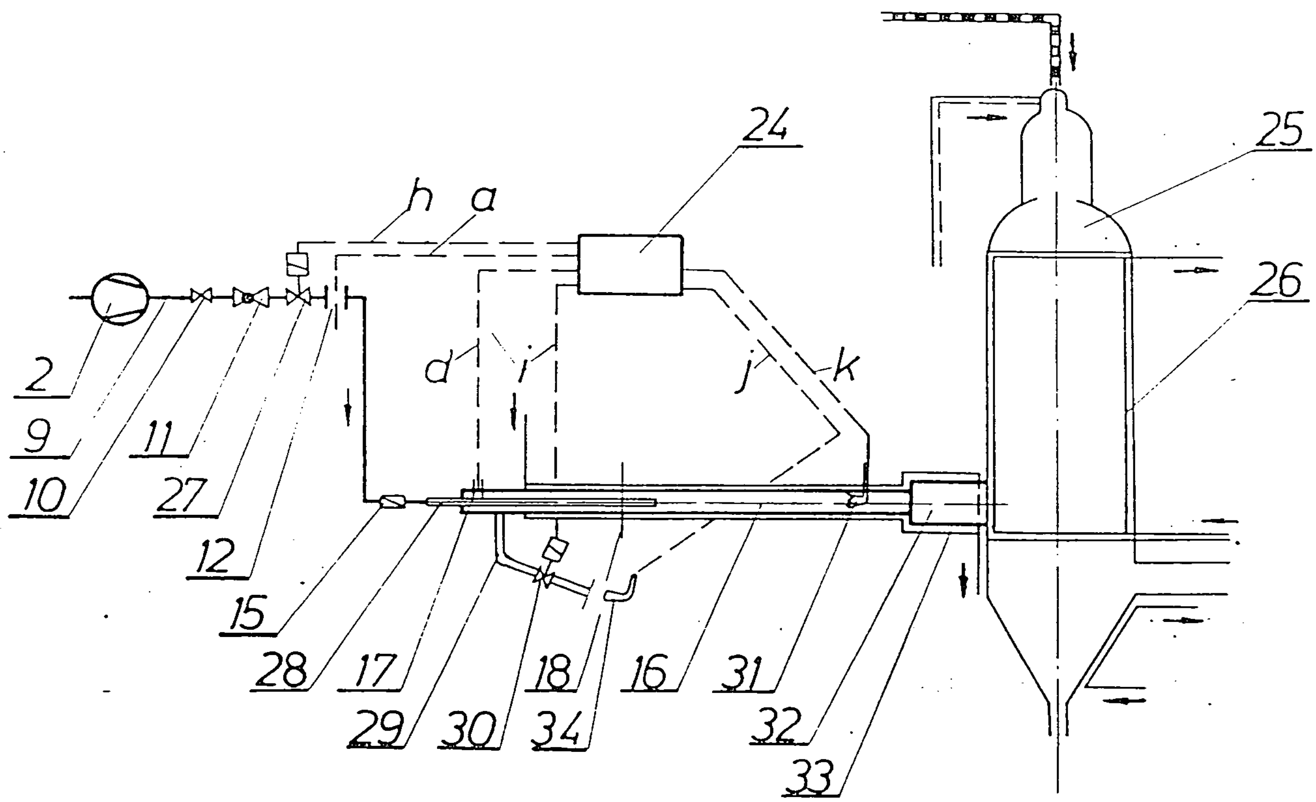
Uređaj za detonaciono-impulsno čišćenje unutrašnjih površina reaktora za visokopritisnu gasifikaciju uglja (varijanta I rješenja)

List.



Slika 2